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Design of Lean Manufacturing to Improve Efficiency of The Coffee Agro-Industry Supply Chain

Iphov Kumala Sriwana[1*], Budi Santosa[1], Hardian Kokoh Pambudi[1], Nida Fariza Maulanisa[1]

[1]School of Industrial Engineering, Telkom University,
Jl. Telekomunikasi, Kota Bandung, 40257.

Corresponding author /E-mail: iphovkumala@telkomuniversity.ac.id

Abstract – **Inappropriate material processing and supplying activities in a coffee agro-industry supply chain potentially lead to excessive waste, resulting in very low efficiency. Efficiency in the coffee agro-industry supply chain has to be considered, since the coffee agro-industry provides relatively high contribution to GDP, approximately 13.7%. Wasteful activities may significantly affect the GDP earned if not being eliminated. This study was aimed to identify waste produced along the coffee agro-industry supply chain and provide recommendations for improving supply chain efficiency, from the harvesting to the ground coffee processing. Actors of the coffee agro-industry supply chain consist of various parties, i.e. farmers, collectors, processors, and consumers. The supply chain is comprised of internal, external, and overall activities in which material and information flows are integrated within business units that traverse simultaneously between direct suppliers and consumers. In order to achieve optimum results, efficiency improvement by eliminating all sources of waste must be carried out at each stage. The method used to obtain this efficiency was Lean manufacturing, initiated with identifying waste using Process Activity Mapping (PAM), followed by identification with Current Value Stream Mapping (VSM). The efficiency value of the current condition was 93,9%. This shows the condition is good and there is no waste in time. There are other waste that needs to be analyzed, namely motion analysis and process**.

Keywords *- Coffee, Efficiency, Supply Chain, Process Activity Mapping, Value Stream Mapping*.

INTRODUCTION

Claimed that Indonesia is the 4th coffee producing country in the world, following Brazil, Vietnam, and Colombia. In addition, as the main coffee producer and exporter, Indonesia plays an essential role in alleviating rural poverty [1]. According to [2], Indonesia's coffee cherries are produced for around 639 thousand tons per year, or 8% of the world's coffee cherries. The high availability of coffee cherries significantly influences sustainability of coffee agro-industry supply chain and provides value added if deliveries are carried out with the highest level of efficiency.

Efficiency in coffee processing is urgently required to increase profits of coffee agro-industry supply chain actors as, according to [3], the agriculture, forestry and fisheries sectors have an important role in economic activities in Indonesia and were capable of contributing to around 13,70% of GDP in 2020. Furthermore, the plantation sub-sector provided the highest contribution to GDP, around 3.63%. The contribution would increase with achievement of high efficiency.

Efficiency is closely related to waste management, as waste gives an impact in a low efficiency [4], and conveyed that waste produced in companies often occurs unconsciously. Furthermore, the companies might not be aware of the waste they are frequently producing.

This research was aimed to identify the waste produced along the coffee agro-industry supply chain, starting from the harvesting to the ground coffee processing and to recommend efficiency improvements. This was carried out because, according to [5], supply chain management is a cycle that can be divided into three primary categories, i.e. internal, external and overall supply chains. The internal supply chain is an integrated flow of

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materials and information within a business unit from suppliers to consumers, otherwise called as business logistics. The external supply chain is an integrated flow of materials and information within business units that traverses between direct suppliers and customers, while the overall supply chain is an integrated flow of materials and information within business units that traverses simultaneously between direct suppliers and consumers.

This research on lean manufacturing was conducted to improve efficiency in the coffee agro-industry supply chain. Efficiency measurement must be carried out since, according to [6], performance efficiency is an important benchmark in measuring the quality of agro-industry. [7] also claimed that an efficient supply chain system is able to optimize profits and provide a fair distribution of the total price paid by consumers to each actor in the coffee supply chain. Achieving efficiency will have an impact on the profit gain of each supply chain actor. Thus, research on lean manufacturing to improve efficiency and to increase profits is essential.

METHOD

According to [8], Lean Supply Chain enhances competitiveness by eliminating all non-value-added activities. Lean supply chain is a strategy focusing on improving processes or increasing efficiency. An application of the lean concept includes identifying sources of waste of cost and activities along the supply chain. The spirit of reducing waste is fulfillment of customer satisfaction. Lean supply chain management is able to play a role in ensuring the fulfillment of customer satisfaction.

The research methodology used in this study was initiated with waste identification using Process Activity Mapping (PAM). Subsequently, a Current Value Stream Mapping (CVSM) analysis was carried out.

Process Activity Mapping (PAM) was used to analyze the overall processing time, followed by classifying these activities based on waste categories. PAM is aimed to eliminate unnecessary activities, identify whether a process is able to be more efficient, and look for improvements that lead to waste reduction [9]. The complete stages are presented in figure 1.

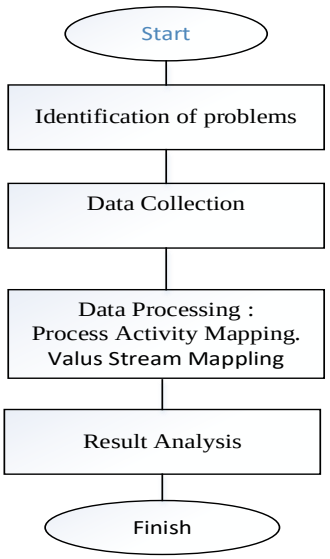

Figure 1. Stage of The Research

RESULTS AND DISCUSSIONS

The coffee supply chain is an integrated activity from upstream to downstream. Upstream activities carried out in this study include harvesting, skin removing, drying, roasting, packing and coffee processing as illustrated in table 1 and table 2.

Table 1. Production Activities for Coffee Production

Work Station	Process	Activity Number	Activity Details
1	Harvesting	1	Picking Coffee Cherries
		2	Sortation
		3	Put the coffee cherries into the sack
		4	Loading to motorcycle
		5	Sending coffee cherries to gapoktan (combine farmer groups)
		6	Unloading coffee cherries
		7	Weighing
		8	Sortation in Gapoktan
2	Production Process	9	Put Coffee Cherries into the reservoir
		10	Flowing floating coffee cheries
		11	Pick up coffee beans from the pond
		12	Putting the coffee beans into the pulper machine
		13	Adding water to the coffee cherries peeling process
		14	Transfer process Coffee beans from Pulper machine to Pool Fermentation

Work Station	Process	Activity Number	Activity Details
3	Inventory	15	Stirring in pool Fermentation
		16	Process Fermentation
		17	Drying
		18	Coffee beans are put in sacks
		19	Process Waiting for temperature Coffee beans down
		20	Coffee Beans Processing on in Machine Huller
		21	Packing
		22	Transfer process to area storage
		23	Grinding
		24	Packing

Table 2. Time Calculation for The Coffee production

Work Station	Process	Activity Number	Processing Time (hour)	Cycle Time (hour)	Transport Time (hour)	O	T	I	S	D
1	Harvesting	1	5	6,25		O				
		2	0,5			O				
		3	0,5			O				
		4	0,25			O				
		5	1		1		T			
		6	0,25	0,35		O				
		7	0,1			O				
2	Production Process	8	0,5	2,60		O				
		9	0,25			O				
		10	0,5			O				
		11	1			O				
		12	0,25			O				
		13	0,1			O				
		14	0,25		0,25		T			
		15	0,25	16.5		O				
		16	14			O				
		17	2			O				
		18	0,25			O				
3	Inventory	19	0,25	0,25						D
		20	0,25	0,5		O				
		21	0,25							
		22	0,25		0,25		T			
		23	0,25	2,25		O				
		24	2							
Total Lead Time				24	28,45					
Total Operation				21	26,7					
% Value adding process				87,5%	93,9					

Based on PAM, the total lead time of wet coffee processing was 28.45 hours, consisting of 24 processes. These 24 processes only required 21 operations, with a total time of 26,7 hours. This shows that there are 3 other activities classified as non-operations or called as non-value-added processes with a total time of 1,75 hours

Holding processes was one of the non-value-added process activities that occurred in the wet-processed coffee supply chain. Holding time occurs in the fermentation process. The fermentation process is used to re-clean the washed coffee cherries. The fermentation process is needed to facilitate the next process. However, in terms of value, this process does not provide value added as it is included to solely clean impurities in the coffee beans. The fermentation process lasts for 14 hours. Based on the PAM that has been constructed, it is noticed that improvement of the supply chain on the aspect of inflows from farmers is necessary, leading to reduction of holding time and faster or shorter supply chain lead time, eventually. The next step was mapped in the Current Value Stream Mapping (CVSM) to find out process conditions being carried out.

Current Value Stream Mapping (CVSM)

To describe the overall condition of the Gapoktan Manglayang supply chain, CVSM was created based on PAM data. This CVSM is illustrated in figure 2.

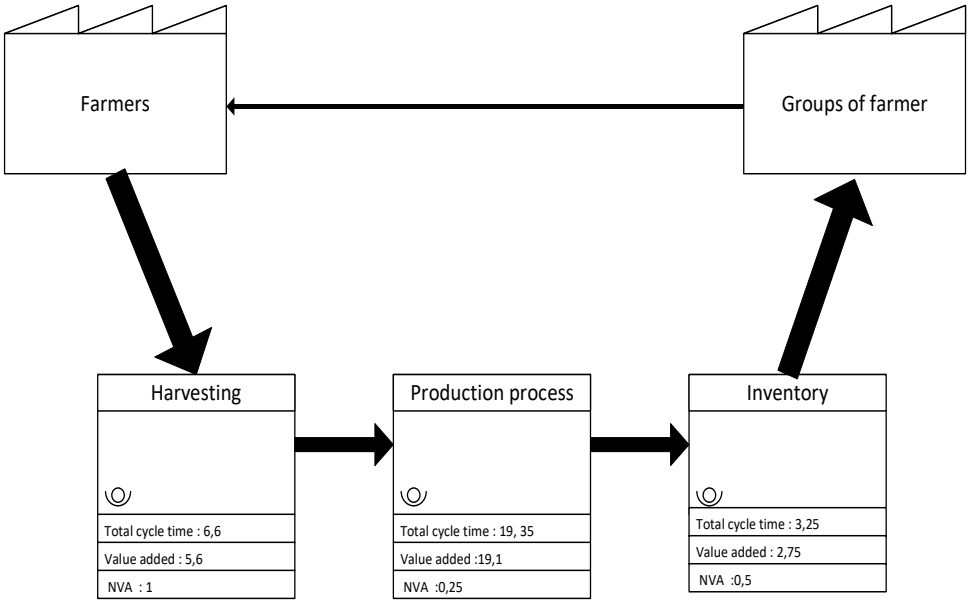

Figure 2. Current Value Stream Mapping

Based on figure 2, it can be seen that the current supply chain shows a total lead time of 28,45 hours. Meanwhile, the value-added processes only require 26,7 hours, indicating that the remaining time was dominated by value-added processes. Based on the analysis, it is known that there was no waste of time. [10] said that there were 7 waste that occurred as can be seen in figure 3.

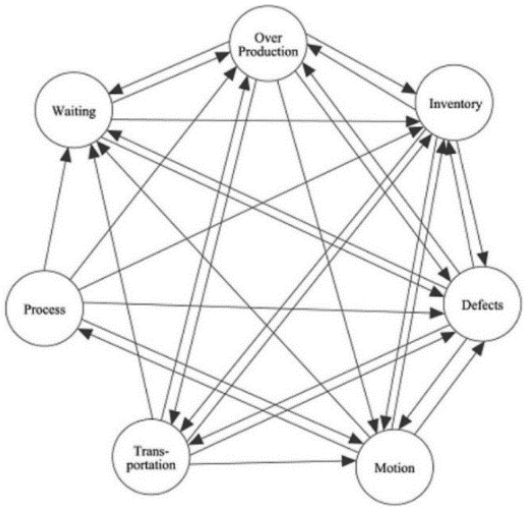

Figure 3. Current Value Stream Mapping

This research only discusses time (waiting process). To get better research results, another 6 waste analysis must be carried out, as seen in figure 4, that the processing of coffee beans can cause waste in motion or process. Thus, recommendations with improvement scenarios to reduce the waste are provided.

Figure 4. Motion dan Process Waste

CONCLUSION

Efficiency regarding reducing wastes in the coffee agro-industry supply chain must be implemented immediately. Based on improvements in motion and waste processing processes, results were obtained that the efficiency value of the previous condition was 93,9%. This shows the condition is good and there is no waste in time factor. However, there are still other waste types that need to be analyzed, namely motion analysis and processing.

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